
Hamakua Marsh (Kailua, O'ahu) Restoration Site Plant Monitoring Survey

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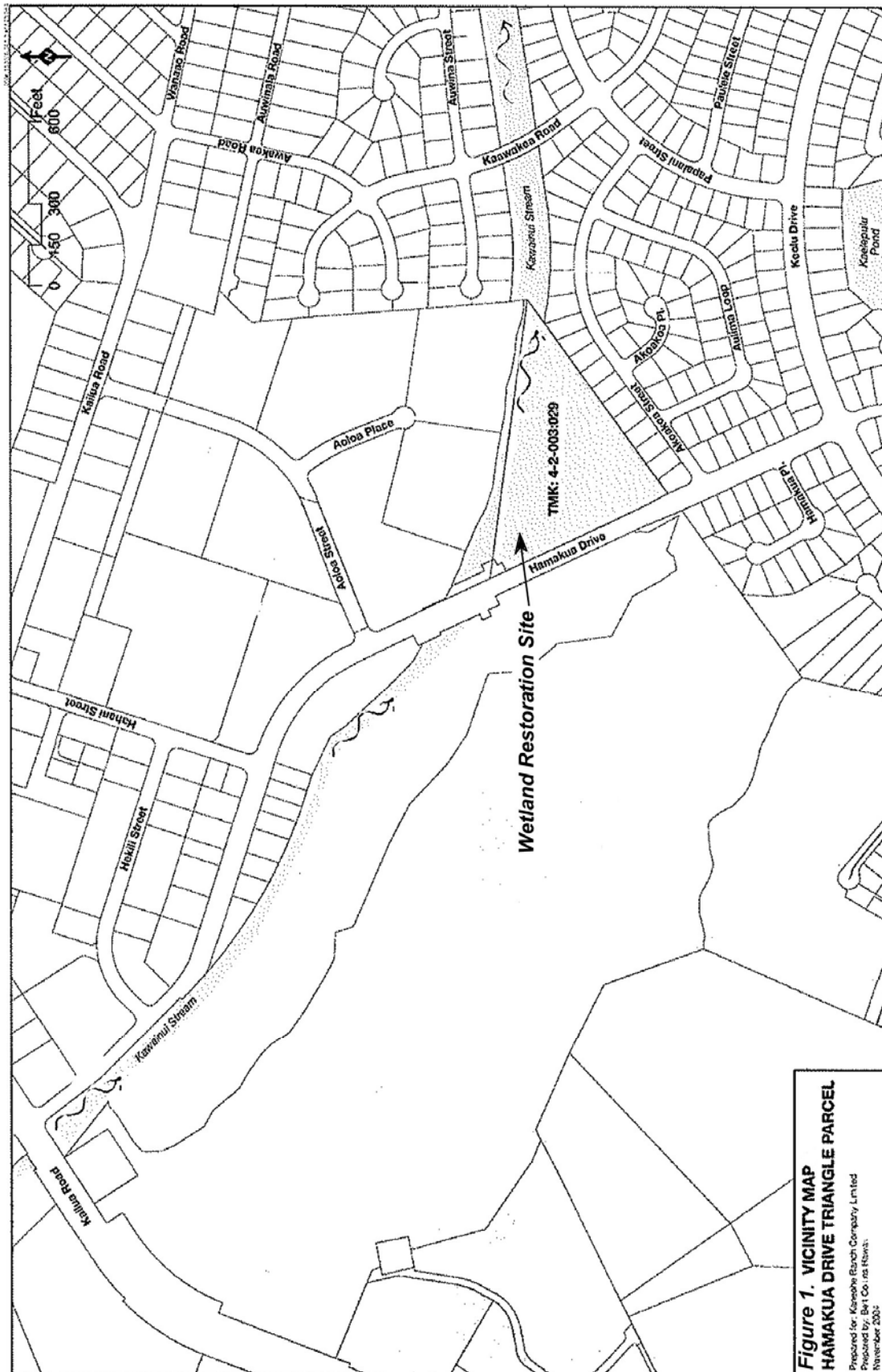
Introduction

This report represents the first monitoring report for a wetlands restoration project at Hamakua Marsh, Kailua, windward O'ahu (Figure 1). The purpose of this report is to document progress towards a wetland restoration that began in April-May 2008 as measured by the results of vegetation transects undertaken approximately 12 months following restoration. Restoration and monitoring requirements are detailed in a Removal/Restoration Plan (SWCA, 2006) in compliance with agreements reached with the U.S. Environmental Protection Agency (EPA) arising from Docket No. CWA-404-309 (a)-06-007 (EPA, 2006) for placing fill material in a wetland located on property owned by Kaneohe Ranch Company.

The restoration site is located on a triangular parcel (TMK: 4-2-003:29) adjacent to Kawai Nui Stream ("Hamakua" Stream in some sources) and is part of the Kaelepulu-Hamakua drainage canal (Fig. 1). Because some of this area was previously a wetland along a drainage channel and fill was placed without a Dept. of the Army permit, restoration back to a wetland was required by EPA.

Survey Methods

To date, three separate plant surveys have been conducted at the Hamakua Marsh restoration site. An initial survey made in May 2008 produced a non-quantitative listing of plants representing conditions during the early stage of physical alteration (grading) of the site (see Fig. 2). A second quantitative



(transect) survey was undertaken on September 22, 2008. Although representing post-restoration conditions, most of the plantings that had been made in June and August of 2008 had or were in the process of failing to thrive. Additional plantings were then made throughout November 2008 (Matt Schirman, Hui Kū Maoli Ola, pers. comm.). Consequently, a third plant survey was undertaken on April 14, 2009. Plantings had by this time taken hold and this survey constituted the first official monitoring of the restoration effort.



Figure 2. South side of the restoration site on May 1, 2008 looking towards Hamakua Drive (behind dust barrier fence). Grading of wetland is ongoing to the right. Stakes mark approximate future shoreline (see Fig. 3).

For the April 2009 survey, vegetation abundance data were obtained from two transects laid along the margins of the restored depression; total transect length was 91 m. These transects were limited to the margins of the restored area because no plants occurred within the shallow pond inside the margin. A metric measuring tape was used. Transect 1 extended to the NE along the southeastern pond shore for a distance of 71 m, the line bending to roughly parallel the



Figure 3. Hamakua Marsh restoration site as it appeared in September 2008 with grading completed and initial plantings made. View is approximately the same as shown in Fig. 2 above.

shoreline, keeping the line at approximately the same distance away from the water. The second transect (20 m long) was laid from the base (0 m point) of first, but in a more northerly direction along the west shore. The location of each end of the two transects was located with a GPS.

An aluminum quadrat frame of dimensions 1.0 by 0.5 m, outfitted with a grid of heavy sugi thread spaced at 10 cm intervals, was used to quantify plant cover. The quadrat frame was placed along a transect (centered on the line) every 0.5 m (see Fig. 4). This approach created a sampling area that was 1-m wide by 91-m long.

Once the quadrat frame was positioned, an observer considered each of the 50 10 x 10 cm squares and recorded the dominant (covering 50% or greater) plant species (or "bare substratum," "leaf litter," or "water" in some cases) within a square. The result of these counts is an estimate of the percent coverage for each species or bottom type within a quadrat, where each scoring represents

2% (1/50) of the 0.5 m² quadrat area. This approach examined 182 contiguous quadrats and proved reasonably efficient to complete in the field, although clearly biased to the shore area as discussed below.



Figure 4. Transect (along SE margin) laid out and quadrat frame in place for counting. Irrigation supply line and sprinkler heads seen to right of line. Note curvature of transect line.

Results

Table 1 presents a species listing of plants observed growing on the triangle parcel in May 2008. This listing provides a baseline of sorts, representing mostly the weedy growth on the cleared portion of the site and trees, scrub, and wetland vegetation seen around the margin. Monitoring of the vegetation on later visits was concentrated on the restored wetland area.

Table 1. Flora listing for the triangle parcel (TMK: 4-2-003:29) in Kailua, O'ahu, Hawai'i at early stage (grading) of restoration project (May 2008).

Species listed by family	Common name	Status	Notes
FLOWERING PLANTS			
DICOTYLEDONES			
ACANTHACEAE			
<i>Asystasia gangetica</i> (L.) T. Anderson	Chinese violet	Nat	<3>
AIZOACEAE			
<i>Sesuvium portulacastrum</i> (L.) L.	'ākulikuli	Ind	<1>
ANACARDIACEAE			
<i>Schinus terebinthefolius</i> Raddi	Christmas berry	Nat	<2>
AMARANTHACEAE			
<i>Amaranthus spinosus</i> L.	spiny amaranth	Nat	<3>
ARALIACEAE			
<i>Schefflera actinophylla</i> (Endl.) Harms	octopus tree	Nat	<2>
ASTERACEAE (COMPOSITAE)			
<i>Bidens alba</i> (L.) DC	beggar's tick	Nat	<3>
<i>Eclipta prostrata</i> (L.) L.	false daisy	Nat	<1,3>
<i>Emilia fosbergii</i> Nicholson	Flora's paintbrush	Nat	<3>
<i>Pluchea carolinensis</i>	sourbush	Nat	<2>
<i>Pluchea indica</i> (L.) Less.	Indian fleabane	Nat.	<1,2>
<i>Pluchia X fosbergii</i> Cooperr. & Galang	---	Nat	<2>
<i>Sonchus oleraceus</i> L.	sow thistle	Nat	<3>
<i>Tridax procumbens</i> L.	coat buttons	Nat	<3>
<i>Cyanthillium cinereum</i> (L.) H. Rob.	little ironweed	Nat	<3>
BATACEAE			
<i>Batis maritima</i> L.	pickleweed	Nat	<1>
BORAGINACEAE			
<i>Heliotropum procumbans</i> Mill.	---	Nat	<3>
COMBRETACEAE			
<i>Conocarpus erectus</i> L.	button mangrove	Nat	<1,2>

Table 1 (continued).

Species listed by family	Common name	Status	Notes
CUCURBITACEAE			
<i>Coccinia grandis</i> (L.) Voigt	scarlet-fruited gourd	Nat	<3>
EUPHORBIACEAE			
<i>Chamaesyce hirta</i> (L.) Millsp.	garden spurge	Nat	<3>
<i>Chamaesyce hypericifolia</i> (L.) Millsp.	graceful spurge	Nat	<3>
FABACEAE			
<i>Desmanthus pernambucanus</i> (L.) Thellung	virgate mimosa	Nat	<3>
<i>Leucaena leucocephala</i> (Lam.) deWit	koa haole	Nat	<2>
<i>Neonotonia wightii</i> (Wight & Arnott) Lackey	---	Nat	<3>
MORACEAE			
<i>Ficus microcarpa</i> L.	Chinese banyan	Nat	<2>
MYRTACEAE			
<i>Syzygium cumini</i> (L.) Skeels	Java plum (juv.)	Nat	<3>
PASSIFLORACEAE			
<i>Passiflora foetida</i> L.	love-in-a-mist	Nat	<3>
PORTULACACEAE			
<i>Portulaca oleracea</i> L.	pigweed	Nat	<3>
RHIZOPHORACEAE			
<i>Rhizophora mangle</i> L.	American mangrove	Nat	<1,2>
SOLANACEAE			
<i>Solanum lycopersicum</i> var. <i>cerasiforme</i> (Dunal) Spooner	wild cherry tomato	Nat	<3>
VERBENACEAE			
<i>Citharexylum caudatum</i> L.	fiddlewood	Nat	<2>
MONOCOTYLEDONES			
CYPERACEAE			
<i>Cyperus javanicus</i> Houtt.	'ahu 'awa	Ind	<1>
POACEAE			
<i>Chloris barbata</i> (L.) Sw.	swollen fingergrass	Nat	<3>
<i>Cynodon dactylon</i> (L.) Pers.	Bermuda grass	Nat	<3>
<i>Digitaria ciliaris</i> (Retz.) Koeler.	Henry's crabgrass	Nat	<3>
<i>Leptochloa uninerva</i> (K. Presl.) Hitchc. & Chase	sprangletop	Nat	<1>
<i>Sporobolus</i> sp.	dropseed	Nat.	<3>
<i>Urochloa maxima</i> (Jacq.) Webster	Guinea grass	Nat	<3>

Table 1 (continued)

Legend to Table 1

STATUS = distributional status for the Haaiian Islands:

- Ind = Indigenous; native to Hawaii, but not unique to the Hawaiian Islands.
 Nat = Naturalized, exotic, plant introduced to the Hawaiian Islands since the arrival of Cook Expedition in 1778, and well-established outside of cultivation.
 Orn = Ornaments; plants that are maintained as part of the landscaping .
 Pol = Aboriginal (Polynesian) introduction; "canoe plants."

NOTES: <1> – Plant generally associated with wetlands.
 <2> – Plant a tree or large shrub; non-native.
 <3> – Plant a ruderal herb or small shrub, non-native.

Quadrat counts from the April 14, 2009 transects (at completion of construction and replanting) are presented in Appendix A. The results are summarized in Table 2.

Table 2. Results of post-construction wetland plant survey on April 14, 2009: average percent "coverage" by plants and bare ground on two transects.

	Percent Cover
BARE SUBSTRATUM	85.1
WATER OVER BARE SUBSTRATUM (Flooded)	3.4
WETLAND PLANTS	
<i>Cyperus javanicus</i> ('ahu'awa)	8.3
<i>Bolboschoenus maritimus</i> (kaluhā)	0.6
<i>Cladium jamaicense</i> ('uki)	0.3
<i>Cyperus trachysanthos</i> (pu'u ka'a)	<0.1
dead plant matter (planted, but not surviving)	0.5
WETLAND MARGIN PLANTS	
<i>Pluchea indica</i>	<0.1
UPLAND PLANTS (native species)	
<i>Myoporum sandwicense</i> (naio)	1.8
<i>Scaevola taccada</i> (naupaka kahakai)	0.6
<i>Colubrina asiatica</i> ('ānapanapa)	0.3
<i>Dodonaea viscosa</i> ('a'ali'i)	<0.1
<i>Jacquemontia ovalifolia</i> (pā'ū ohi'iaka)	<0.1
MISCELLANEOUS WEEDS (FAC OR UPLAND PLANTS)	
non-native herbs	0.2

Conclusions

The site has been physically restored, plantings completed, and most of the shallow margin populated by emergent herbaceous vegetation resulting from plantings. The purpose of the vegetation monitoring is to confirm that a vegetated wetland with certain wetland values has become established. Vegetation is the most practical way to interpret whether a wetland has or has not been established. Quantitative coverage values by species can be used to conclude whether certain restoration goals have been met.

Plant growth as of May 2009 could be described as sparse with 88.5% of the transect area lacking vegetation (Table 2). It is anticipated that over time plantings will spread, covering most of the transect area and extending further into the shallow water near the shore. Deeper water areas may or may not remain unvegetated, although EPA's Findings of Violation and Order for Compliance dated April 2006 specifies that between 25% and 100% of the area should remain as open water (or less than 75% dominated by plant cover) to provide wading habitat for *Ae'o* or Hawaiian stilt (*Himantopus mexicanus knudseni*). *Ae'o* are now utilizing the restoration area. Our results of 88.5% unvegetated is not to be interpreted as representative of the site as a whole because the April 2009 transects were purposely laid through the vegetated margin of the restored wetland pond. Presently, vegetation occupies less than 1% of the entire area.

It is worth noting that the vegetation present as of April is almost entirely native plants. Within the transect area, less than 0.3% of the area is occupied by non-native plants. Return visits are scheduled at yearly intervals from the date of completion of construction and continuing through 2011.

References

- SWCA Environmental Consultants (SWCA). 2006. Revised Hamakua Drive Wetland Removal & Restoration Plan, Kailua, Oahu, Hawaii, EPA Docket No. CWA-404-309 (a)-06-007.
- U. S. Environmental Protection Agency (EPA). 2006. Findings of Violation and Order for Compliance under Sections 308 and 309(a) of the Clean Water Act, EPA Docket No. CWA No. CWA-404-309(a)-06-007. April 24, 2006.

Appendix A

Quadrat Data Results - April 14, 2009

Transect 1 QUADRAT	WETLAND PLANTS				UPLAND PLANTS		
	Ahu'awa	Bolbosc.	akiaki	dead	P. Indica	Cham. Hyper	E. Alba
0	4	1				3	
0.5	2			1		1	3
1				5			2
1.5							
2							
2.5							
3							
3.5							
4							
4.5							
5	14						
5.5	18						
6							
6.5							1
7	1						1
7.5	15						
8	1						
8.5	10						
9	2						
9.5			1				
10	1						
10.5	2						
11	3						
11.5							
12							
12.5							
13	3						
13.5	10						
14	1						
14.5	2		2				
15	1						
15.5	4						
16	7						
16.5	4						
17	3						
17.5	1						
18	1						
18.5	2						
19							
19.5							
20							
20.5							
21	1						
11.5	1						

[illegible]

Transect 1 QUADRAT	WETLAND PLANTS				UPLAND PLANTS		
	Ahu'awa	Bolbosc.	akiaki	dead	P. Indica	Cham. Hyper	E. Alba
22							
22.5	9						
23							
13.5							
24							
24.5	5						
25	9						
25.5	14						
26	9						
26.5	16						
27	18						
27.5	25						
28	31						
28.5	31						
29	45						
19.5	10						
30	7						
30.5							
31							
11.5							
32	2			3			
32.5	7			3			
33	20						
33.5	18						
34	9						
34.5							
35							
35.5				2			
36				3			
36.5				4			
37	1			1			
37.5	5	4					
38	14			1			
38.5	11						
39	4	4					
39.5	12						
40	9						
40.5	4						
41	1						
41.5	1						
42	7						
42.5	8						
43							
43.5							

[illegible]

Transect 1 QUADRAT	WETLAND PLANTS				UPLAND PLANTS		
	Ahu'awa	Bolbosc.	akiaki	dead	P. Indica	Cham. Hyper	E. Alba
44	1	1					
44.5	6						
45	23						
45.5							
46							
46.5	1			2			
47	5						
47.7	13						
48	15						
48.5	17						
49	15						
49.5	9						
50	1						
50.5	3						
51	11	3					
51.5	10	1					
52	17						
52.5	7						
53	4	4					
53.5	1			4			
54	3	3					
54.5	2						
55							
55.5	2						
56	8						
56.5	4						
57	3						
57.5	4						
58							
58.5							
59							
59.5	2						
60							
60.5							
61							
61.5							
62							
62.5							
63							
63.5	12						
64	8						
64.5	2						
65							
65.5	7						

[illegible]

Transect 1 QUADRAT	WETLAND PLANTS				UPLAND PLANTS		
	Ahu'awa	Bolbosc.	akiaki	dead	P. Indica	Cham. Hyper	E. Alba
66	7						
66.5							
67							
67.5	1						
68	1				2		
68.5	2						
69	3						
69.5							
70							
70.5							
71							
71.5							

Transect 2 QUADRAT	WETLAND PLANTS				UPLAND PLANTS		
	Ahu'awa	Bolbosc.	akiaki	dead	P. Indica	Cham. Hyper	E. Alba
0							
0.5							
1							
1.5							
2							
2.5							
3							
3.5							
4	1						
4.5							
5							
5.5							
6							
6.5							
7				1			
7.5							
8				1			
8.5			6				
9			5				
9.5			1	2			
10				6			
10.5				4			
11	4						
11.5							
12	7						
12.5			2				
13			5				
13.5		3					
14			1				

[illegible][illegible]

Transect 2 QUADRAT	WETLAND PLANTS				UPLAND PLANTS		
	Ahu'awa	Bolbosc.	akiaki	dead	P. Indica	Cham. Hyper	E. Alba
14.5	2						
15	11						
15.5	10	4					
16	1	10					
16.5	6	7					
17	3						
17.5		2					
18							
18.5			1				
19		4	1				
19.5		2					
20		3					
TOTAL	751	56	25	43	2	4	7
MAX	45	10	6	6	2	3	3
MIN	1	1	1	1	2	1	1
% COVER	8.3	0.6	0.3	0.5	0.02	0.0	0.1

Transect 2	UPLAND PLANTS								
QUADRAT	Floras	Ager.	Naupaka	Naio	aalii	Anapa	Jacq	water	bare
14.5								36	2.5
15								22	2
15.5								15	5.5
16								21	2
16.5								22	1.5
17								24	6
17.5								16	14.5
18								23	9
18.5								21	9.5
19								12	14
19.5								3	25.5
20								2	25
TOTAL	4	2	56	165	1	25	4	309	4180
MAX	1	1	18	23	1	8	4	36	50
MIN	1	1	1	1	1	1	4	2	0.5
% COVER	0.0	0.0	0.6	1.8	0.0	0.3	0.0	3.4	45.9